UNITED STATES COUNCIL FOR AUTOMOTIVE RESEARCH LLC

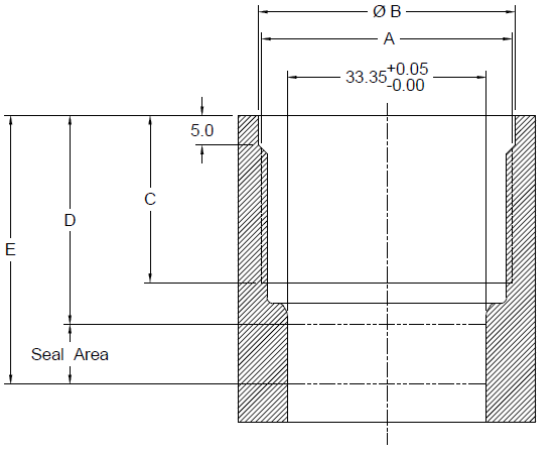
USCAR Hydrogen Fuel System Component Working Group (H2FSC WG) - Targets for a Tank Valve on a light-duty fuel cell vehicle

The purpose of this document is to promote common requirements and designs for use by the H2FSC WG.

The 700 bar tank valve shall isolate compressed hydrogen in the tank when vehicle is off and supply compressed hydrogen from the tank to downstream components of the fuel cell system in driving mode.

Characteristic	Target – Tank Valve	Reference/Source*
Fuel	Hydrogen per ISO 14687	ISO 14687 (ref. SAE J2719)
Hydrogen Compatibility	Evidence of Hydrogen Compatibility	ANSI HGV 3.1-2015 SAE J2579 Appendix B
Nominal Working Pressure	700 bar	H2FSC WG
Maximum Operating Pressure	875 bar (1.25x NWP)	ANSI HGV 3.1-2015
Burst Pressure	1750 bar (2.5x NWP)	ANSI HGV 3.1-2015
Minimum Tank Pressure – Max Outlet Flow	15 bar	H2FSC WG
Minimum Tank Pressure – Reduced Outlet Flow	5 bar	H2FSC WG
Thermally Activate Pressure Relief Device (TPRD)	110°C±5°C No restricted flow after activation Certified per ANSI/CSA HPRD 1	H2FSC WG
Manual Lock-off	Shall container manual valve to isolate gas flow in/out of tank 50 open/close cycles without loss of function	H2FSC WG
Bleed Device	Shall container manual bleed device to allow gas flow out of tank Preferred to vent through valve outlet port	H2FSC WG
Maximum Outlet Flow (includes pulse conditions per OEM feedback)	3 g/s**	H2FSC WG
Maximum Average Outlet Flow	1.5 g/s**	H2FSC WG
Max Flow During Refueling	60 g/s	SAE J2601
Pressure Drop During Refueling	Should meet pressure drop requirements per SAE J2601 (value in agreement with OEM)	SAE J2601
Maximum Inlet Check Valve Crack Pressure	5 bar (other values may be specified by OEM)	H2FSC WG
Solenoid Voltage Supply (to open)	9-16 VDC	H2FSC WG
Solenoid Voltage Supply (hold open)	<9 VDC	H2FSC WG
Solenoid Current Supply (to open)	<5 Amp	H2FSC WG

Solenoid Current Supply (hold open)	<1 Amp	H2FSC WG
Transient Response Rate (Open/Close)	<500/100 milliseconds	H2FSC WG
Maximum Service Temperature (Ambient and Operation)	85°C (Maximum environmental ambient is 50°C)	ANSI HGV 3.1-2015
Minimum Service Temperature	-40°C	ANSI HGV 3.1-2015
Maximum Gas Temperature	85°C	H2FSC WG
Minimum Gas Temperature	-60°C	H2FSC WG
Endurance Test (pneumatic)***	75,000 Cycles (1.5x 50k duty cycles)	EC/79/2009
Pressure Cycle Test (hydraulic)***	150,000 Cycles (3x 50k duty cycles)	EC/79/2009
Refueling Endurance Test (pneumatic)***	7,500 Cycles (1.5x 5k duty cycles)	EC/79/2009
Refueling Pressure Cycle Test (hydraulic)***	15,000 Cycles (3x 5k duty cycles)	EC/79/2009
Maximum External Leakage	< 10 Ncm^3/h (end of life)	ANSI HGV 3.1-2015
Maximum Internal Leakage	< 10 Ncm^3/h (end of life)	ANSI HGV 3.1-2015
Component Certification Requirement	ANSI HGV 3.1-2015 (USA) EC/79/2009 or UN R134 (Europe) Must comply with applicable local and national regulations in which deployment will occur per customer (above are typical references)	H2FSC WG
System Certification Compliance (System Criteria Awareness)	UN GTR No. 13 UN R134 SAE J2579	H2FSC WG
NVH Requirement	No subjectively disturbing noises are allowed at any normal vehicle operating conditions per OEM feedback and assessment Needs to be robust to shock loads and vibrations exposed to during normal operation as determined for the specific customer and vehicle application	H2FSC WG
Corrosion Protection***	144 hours salt spray	ANSI HGV 3.1-2015
Water Ingress Protection***	IPx6 (high-pressure, heavy spray) IPx6K (extreme high-pressure spray)	ISO 20653
Thermal Endurance***	At minimum, perform 100 temperature cycles between minimum and maximum service temperature in 5 minutes with a 30-minute hold at temperature For complete endurance assessment, needs to be robust to thermal fatigue and degradation that is caused by temperature change. Perform a customer defined thermal cycle profile	H2FSC WG (ref. IEC 60068-2-14)
Required Integration Functionality	Solenoid Valve TPRD Manual Lock-Off Bleed Device Filter (10 µm) on inlet	H2FSC WG

<table>
<tr><td>Optional Integration Functionality
(examples of integration but not limited to this list per customer design)</td><td>Excess Flow Valve
Inlet Check Valve
High Pressure Ports or Sensors
In-Tank Temperature Sensor</td><td>H2FSC WG</td></tr>
<tr><td>Weight</td><td>< 2 to 3 kg depending on level of integration</td><td>H2FSC WG</td></tr>
<tr><td>Minimum Lifetime</td><td>15 years</td><td>H2FSC WG</td></tr>
<tr><td>Service Criteria</td><td>Shall not require any scheduled maintenance involving disassembly and/or replacement of parts to maintain proper function over lifetime</td><td>H2FSC WG</td></tr>
<tr><td>Tank Seal Interface</td><td>Single radial seal mounted on valve
Seal location as shown in tank port interface</td><td>H2FSC WG</td></tr>
<tr><td>Tank Port Interface</td><td> 

<table>
<tr><th></th><th>Option 1</th><th>Option 2</th></tr>
<tr><td>A</td><td>1 ½-12 UNF-2A</td><td>M42X2-6H</td></tr>
<tr><td>B</td><td>46 mm</td><td>43 mm</td></tr>
<tr><td>C</td><td>40 mm</td><td>28 mm</td></tr>
<tr><td>D</td><td>46 mm</td><td>35 mm</td></tr>
<tr><td>E</td><td>58 mm</td><td>45 mm</td></tr>
</table>
Tank valve should accommodate overall port length for both a non-neck mounted and neck mounted tank for gas injection into the tank to avoid impingement on tank port

It is recommended that tank boss part have a 90° step transition from geometry B to thread A, to precisely position the main tank valve seal within seal area of the tank boss.

It is further recommended that the tank boss part has a transition from its main thread area C to the seal area D-E (not to damage O-Ring during assembly) designed within the following ranges:
• Transition angle: 13° to 30°
• Transition radius: 0.5 to 2.5 mm
• Max surface roughness: Ra 0.8</td><td>H2FSC WG</td></tr>
</table>

Outlet Fitting Interface	Female cone end-connection per ISO 2974 *(6 mm OD tubing interface)*	H2FSC WG
Excess Flow Limiter (optional feature)	Values to be specified by OEM	H2FSC WG
TPRD Interface (optional feature although design should consider accommodating)	Port interfaces as specified by OEMs *Options to consider: Female cone end-connection per ISO 2974 or O-Ring face seal connection per SAE J1453 (6 mm OD tubing interface)*	H2FSC WG
Sensor Port Interfaces (optional feature although design should consider accommodating)	Port interfaces as specified by OEMs *Options to consider:7/16"-20 UNF SAE J1926 (-4 size) 1/2"-20 UNF with port for ⌀7.7 mm stud seal*	H2FSC WG
Electrical considerations for optional pressure sensors (either separate sensors or integrated directly into tank valve)	Single electrical connector shall be directly attached to the unit in agreement with OEM Voltage supply shall be 5 +/- 0.25 VDC with full function in this range at any operating condition (supply current in agreement with OEM) Output signal shall be 0.5 to 4.5 VDC radiometric (other outputs may be specified by OEM)	H2FSC WG
Electrical Connector	Electrical connector recommended be connected directly to the valve and meet electrical requirements as stated in this document. If not using directly mounted electrical connector, an approach to restrain the external connector should be provided.	H2FSC WG
Restricted Materials	Must avoid use of hazardous substances (for example, parts containing lead, mercury, cadmium, hexavalent chromium, etc.) per government regulations, environmental goals, and vehicle manufacture list of prohibited substances (suppliers are required to report)	H2FSC WG (ref. EPA TSCA Inventory, EU Directive 53/2000, other applicable national and OEM restrictions)

**Reference/source information provide the foundation or additional information for the requirement. The "HSFSC WG" notation indicates the requirement was developed by the Hydrogen Fuel System Component Working Group rather than another source.*
***Flow rates are based on a light duty fuel cell vehicle (~80 to 100 kW) and will increase for higher power fuel cell vehicles.*
****At the completion of the test, the component shall comply with the external leakage, internal leakage, and burst pressure requirements.*

NOTE: This list of targets represents the core requirements for the basic design while a series-production product will have additional criteria per vehicle manufacture such as but not limited to:

- design validation for lifetime robustness in vehicle environmental conditions
- electromagnetic compatibility (EMC) requirements for electrical components
- quality control, reliability and production part approval process requirements
- suitable materials and lubricants to prevent fuel cell contamination
- material requirements including recyclability and recoverability